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HOW NEW TAX LAW DEPRECIATION AFFECTS REPLACEMENTS

by

Paul T. Norton, Jr.
Industrial Engineer

I. Purpose of new tax law revisions

A. To bring tax depreciation more nearly in line with actual depreciation.

President Eisenhower's budget message of January 21, 1954, included the following statement regarding depreciation tax practice under the Internal Revenue Code of 1939:

> "The deductions allowed, especially in the early years, are often below the actual depreciation. This discourages long-range investment on which the risks cannot be clearly foreseen. It discourages the early replacement of old equipment with new and improved equipment. And it makes it more difficult to secure financing for capital investment, particularly for small business organization."

The report of the Senate Finance Committee on the bill which became the Internal Revenue Code of 1954 included the following statement:

> "The liberalized declining-balance method included in the bill concentrates deductions in the early years of service and results in a timing of allowances more in accord with the actual pattern of loss of economic usefulness."

B. To maintain a high level of investment in plant and equipment by removing the deterrents inherent in previous tax practice. This purpose is clearly stated in the quotation given above from the President's budget message. Much confusion has resulted from frequent claims that the 1954 liberalization provides "incentives" for investment in plant and equipment. As one industrial executive states in the February 1955 Business Record of the National Industrial Conference Board: "If a project is worth while, funds will be forthcoming from inside or outside the company. If not, accelerated depreciation won't launch it." However, it can often be demonstrated conclusively that an investment which would be very desirable if it could be written off rapidly for tax purposes, would be completely undesirable if written off more slowly for tax purposes. In other words, high depreciation allowances cannot change a bad investment into a good one, but low depreciation allowances for tax purposes can often change an otherwise good investment into a bad one.

C. Purpose of the 1954 change was very different from that of the 60-month amortization of 1940. The purpose of the 60-month amortization privilege of 1940, and similar provisions of more recent years, definitely was to provide an incentive for private investments that otherwise would not have been made. In 1940 it was not expected that these "emergency facilities" would have any particular earning power after the war, but as time went on and the privilege was extended to more and more classes of assets, it became evident that a large portion of these "emergency facilities" would have real earning power in the post-war period. Under these circumstances, many businessmen and accountants felt that it was appropriate to use the "amortization" charges for tax purposes only and to use lower charges at regular depreciation rates for all financial purposes, including the determination of reported profits.

In view of the emphasis placed by many persons on the "incentive" aspects of the 1954 changes, it may have been natural that many businessmen and accountants should have taken the same viewpoint toward the 1954 changes as they had taken toward the 60-month amortization privilege. What these persons have apparently overlooked is the fact that the 60-month amortization privilege was enacted specifically as an incentive for making investments that the government wanted made and which presumably would not otherwise have been made, while the 1954 change was primarily a recognition of the fact that actual depreciation occurs more rapidly in the early years of life. In addition, the 1954 liberalization is available for all investments made in 1954 and later years, in new assets.

It would certainly seem that those businessmen who use the higher rates of the 1954 Code for tax purposes only are acknowledging the truth of the accusation, so often made since 1934, that businessmen are interested in greater depreciation allowances only as a means of reducing their taxes. This seems the more true in those cases where an item of "reserve for deferred taxes" is shown on the balance sheet; if taxes are really deferred under these circumstances, it must mean that the profits shown on the tax return are less than the real profits as shown on the annual report. This practice seems certain to be attacked by those persons who will cer-

tainly seek in 1956 to eliminate the depreciation liberalization of the 1954 Code.

II. Impact of new tax law depreciation on rate of return

A. A more rapid tax-free recovery of an investment is always desirable: "A bird in the hand is worth two in the bush." As an illustration of how a more rapid tax-free recovery of an investment increases the rate of return on an investment, consider the following example: A certain machine has a first cost of $10,000, and zero salvage value at all times from age 10 to age 15. The total service life is 15 years, but the machine has no real earning power after 10 years, and is retained merely for necessary stand-by service during the last five years of life. Receipts exceed cash disbursements by $5,000 in the first year and this amount decreases by $500 each year until it is only $500 in the 10th year. Cash receipts just equal cash disbursements during each of the last 5 years. It is obvious that any part of the investment that is not recovered during the first 10 years cannot be recovered at all from the operations of this machine. However, under the law from 1934 through 1953, it would have been necessary to write off this investment for tax purposes on a straight-line basis over the entire service life of 15 years. Even under the 1954 Code, the 15-year service life must be used in determining the annual depreciation charges, but there is now an opportunity to write off the investment more rapidly in the early years by using either the declining-balance method or the sum-of-year-digits method.

Rate-of-return calculations made by means of the Joel Dean discounted cash-flow method, assuming year-end cash receipts and disbursements and a corporate tax of 50%, show the following annual rates of return on the investment in this machine: nearly 20% with sum-of-year digits method and 10-year write-off period, about 18% with straight-line method and 10-year write-off period, about 18% with sum-of-year digits method and 15-year write-off period, and only about 16% with straight-line method and 15-year write-off period. It will be noted that these differences in actual rates of return on the investment, varying from about 16% to about 20%, are caused entirely by changes in depreciation methods and in lives used in setting depreciation rates; there were no changes in anything else.

Even under the 1954 Code, taxpayers are penalized when assets are retained during their final years merely for necessary stand-by service, because even now it is not possible to recover tax-free the entire investment during the period of actual earning power. It will be noted that in the example just given the period of actual earning power is limited to the first 10 years, at the end of which there is an investment still to be charged off for tax purposes of $3,333 under the straight-line method required by the 1939 Code. This penalty has been reduced considerably by the 1954 Code, under which the remaining investment still to be charged off for tax purposes at the end of the first 10 years is reduced to $2,390, with the declining-balance method and to $2,250 with the sum-of-year-digits method.

B. A tax reduction in early years is not always followed by a tax increase in later years. Many persons have stated that it tax rates remain the same, the total taxes paid over the life of an asset will be the same regardless of whether the investment is written off by means of the straight-line method or one of the other methods permitted by the 1954 Code. Such statements presuppose that there will be annual earnings throughout the entire service life equal at least to the annual straight-line charge. Experienced businessmen know only too well that there is never any assurance that there will be earnings throughout the entire service life of an asset. The rates of return in the examples of the preceding section show the extent of the increase in the rate of return when the higher depreciation rates are used for tax purposes.

The rates of return calculated in the preceding section for depreciation rates based on a 15-year life assume that there will be earnings from other operations sufficient to absorb the investment remaining after 10 years which cannot be recovered out of the earnings of the machine being studied. If there are no earnings from other operations that can absorb the remaining investment, the rate of return on the investment in this machine would be reduced from about 18% to about 17.5% with the sum-of-year-digits method and from about 16% to about 15% with the straight-line method. Higher early depreciation rates produce higher rates of return on invested capital and in addition, today's tax saving is real while a

hoped-for future tax saving may never materialize.

C. The retention of an asset may be justified because of a low annual cost of extending its service. Consider further the asset of the two preceding sections which has zero salvage value at all times during its last 5 years of life. Suppose that instead of it being used only occasionally for stand-by service during these last 5 years of life, this machine can be used regularly during that period on a new job. Suppose also that a new and more efficient machine can be purchased for use on this new job, and that the annual savings due to the new machine would be exactly equal to the annual fixed charges on the new machine. It is obvious that under these quite reasonable assumptions there would be no net advantage in making the replacement and that the existing machine would be used for the new job. It is obvious also that no unrecovered investment in the existing machine can be recovered from the future operations of the existing machine. Therefore, any part of the investment in the existing machine that has not been charged off for tax purposes during the first 10 years of life has resulted in a capital levy under the guise of a tax on profits.

In other words, because annual savings due to a more efficient new machine must be more than the fixed charges on the new machine in order to justify a replacement, it is often desirable to extend the service of an existing machine beyond the period during which any part of its investment can be recovered from its own operations. Nevertheless, under the tax practice from 1934 through 1953, only two-thirds of the investment in the machine under discussion could have been charged offfor tax purposes during the period of real earning power.

III. Group depreciation versus the item method under the 1954 Code

A. Because of mortality dispersion, the group method is the normal method and it is simpler from a bookkeeping viewpoint. Statistical studies have proved that physical property units are somewhat like human beings in their mortality characteristics. For example, if one starts with 100 identical units, installed at the time and with an average life of 10 years, some of the units will be

retired short of 10 years and others will last longer than 10 years. Because of this mortality dispersion, the group method is the normal depreciation method. As everyone knows, the group method requires less bookkeeping than the item method where there are many units of the same average life.

B. Certain Treasury restrictions are due to Treasury recognition of mortality dispersion and the group concept. Since 1934, Treasury regulations have prohibited the charging off of the so-called "losses on premature retirement," except where a retirement is due to such things as casualties and other factors not considered when the average life was estimated. This prohibition will undoubtedly continue under the 1954 Code, as the tentative regulations state that: " ... if the rate is based on the average useful life, no loss is allowable on the normal retirement of an asset since the use of a rate based on the average useful life contemplates that some assets will be retired before and that others will be retired after the end of the average useful life." These same Treasury regulations explain in detail why this restriction cannot be circumvented by using item depreciation unless the depreciation rate is based on maximum life rather than on average life. This Treasury restriction is due to their recognition of the effects of mortality dispersion, and under the circumstances, the group methods seems the most logical method in most situations.

C. Group accounts under declining-balance method. Little attention seems to have been given to certain advantages inherent in open-end declining-balance group accounts when used with assets having large numbers of items and frequent acquisitions and retirements. As is clearly shown on pages 409 to 421 of the 1955 revised printing of DEPRECIATION by Grant and Norton, under the circumstances cited the declining-balance method tends to give, after a few years, about the same annual depreciation charge as does the straight-line method, although with the declining-balance method the investment in each individual asset is written off more rapidly. This should be of great interest to industrial managers who wish to find some single method that will best meet both their tax and financial objectives.

The information in the new Chapter 19 of the revised printing of DEPRECIATION by Grant and Norton also proves that in the average case the remaining undepreciated balance at end of life inherent in the declining-balance method is not nearly as important as it is generally supposed to be. In fact, this figure is apt to be much less than the 10% to 13% figure generally cited by those persons who consider this characteristic of the method to be a disadvantage that must in some way be eliminated.

D. Group accounts under sum-of-year-digits method. This method has characteristics that make it most suitable for use with assets that are few in number, have large unit investments, and for which the item method is clearly appropriate. The tentative Treasury regulations suggest a way of using this method with open-end group accounts, but the stated requirements seem to the writer to involve too many complications.

> If this method is to be used for group accounts, the writer believes that a new account should be formed for the acquisitions of each year. If that is done, the writer suggests the following substitute for the tentative Treasury proposal: Prepare a schedule of annual write-offs at the time of acquisition for the entire estimated average life of the group and follow this schedule throughout such life without regard to retirements prior to the end of such average life. For retirements prior to the average life, the asset account would be credited and the reserve account would be debited with the first cost of the retired asset, and the entire account would become fully depreciated at the end of the average life. This would be following the practice so generally used for such non-catalogued plant as wiring, piping, roof repairs, etc. Calculations made by the writer indicate that the annual depreciation charges under his proposal would be much like those of the tentative Treasury regulations, but with calculations that are much simpler. (Estimated and realized salvage can easily be taken care of under the writer's proposal.)

E. Effect of group method under 1954 Code on management decisions. Anyone who examines carefully the effects of using the newly permissible group methods of the 1954 Code must surely be fascinated with the possibilities of finding methods that will under certain circumstances satisfy both tax and financial objectives.

> As just one illustration, consider the effect of the group declining-balance method on management decisions with respect to retirements. When the group straight-line method is used, each asset is responsible for the same annual depreciation charge throughout its entire life regardless of how old it becomes before retirement or how little it is used in the last portion of its life. For example, with a group straight-line rate of 8%, an asset that originally cost $10,000 will be responsible for a depreciation charge of $800 per year as long as it is retained in service no matter if it is only used occasionally for standy-by service during its final years, but this charge can be eliminated completely by merely retiring the asset. From a cost-accounting viewpoint, this penalizes the operating head of the department or plant having such an old asset, and thus acts as an arbitrary incentive for the retirement of assets that from a purely economic viewpoint should be retained in service.

This undesirable characteristic of the group straight-line method does not exist with the group declining-balance method, where the retirement of an asset at any age with zero salvage value has no effect whatever on the annual depreciation charge.

IV. Effect of new tax law depreciation on obsolescence.

A. Decrease in value during life received no consideration in tax practice between 1934 and 1953. Treasury officials and many accountants maintain that obsolescence was recognizedfully in the pre-1954 tax practice because the effects of "normal" obsolescence could be considered when setting the original depreciation rate, while this rate could be adjusted if it ever became evident that "extraordinary" obsolescence would shorten the life originally estimated. However, it is obvious that in both cases it was the effect of obsolescence in ending the service life that was recognized in the pre-1954 practice. Businessmen know only too well that it is the effect of obsolescence in reducing "value to the owner" during life that is most important. This important effect of obsolescence was not recognized in any way in the pre-1954 practice.

B. The 1954 Code has an important indirect effect on obsolescence. There is nothing in the wording of the 1954 Code or the tentative Treasury regulations to indicate any change in attitude toward either "normal" or "extraordinary" obsolescence. But it is obvious that such newly permissible methods as the declining-balance method and the sum-of-year-digits method allow investments to be written off more nearly in accordance with the usual pattern of decrease in "value to the owner." This is apparently not fully understood by those persons who consider only the investment incentive aspects of the 1954 changes and who advocate taking the higher depreciation allowances for tax purposes only.

CAPITAL BUDGETING

The October, 1955 issue of Journal of Business published by the School of Business of the University of Chicago, contained a series of articles on "Capital Budgeting." These are:

THREE PROBLEMS IN RATIONING CAPITAL
James H. Lorie and Leonard J. Savage

MEASURING A COMPANY'S COST OF CAPITAL
Ezra Solomon

THE PAYOFF PERIOD AND THE RATE OF PROFIT
Myron J. Gordon

HAS MAPI A PLACE IN A COMPREHENSIVE SYSTEM OF CAPITAL CONTROLS?
Joel Dean and Winfield Smith

RESIDUAL VALUES IN INVESTMENT ANALYSIS
Gordon Shillinglaw

CAPITAL EXPENDITURE MANAGEMENT
Horace G. Hill, Jr.

ADMINISTRATIVE ORGANIZATION IN CAPITAL BUDGETING
Frank E. Norton

These articles have been analyzed as a whole by Professor Maffai. Because of the special interest in the concept of a payoff period for capital equipment, the paper on "The Payoff Period and the Rate of Profit," has been reviewed as an entity by Professor Abruzzi.

* *

CAPITAL BUDGETING: AN OVERVIEW

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The editorial staff of the Journal of Business has performed a valuable service for businessmen and academicians alike by assembling into one issue of the Journal so many informative and thought provoking articles relating to the concepts and problems of capital budgeting.[1] The very nature of the economic significance of business investment decisions as they relate to the processes of the survival and growth of individual firms attests to the singular importance of the discussions undertaken.

1. The Journal of Business, The School of Business of the University of Chicago, University of Chicago Press, Chicago, Illinois, Volume XXVIII, October 1955.

Top managements and boards of directors, vested with the obligation of trusteeship, have long been aware of the need for good decision rules that would enable them to make "effective" capital replacement and capital expansion decisions. Recent economic theory clearly demonstrates the central importance of aggregative investment as a determinant of the level of national income and gross national product. It is important to recognize that the implications of decision rules as they affect business investment decisions are more far-reaching than usually regarded. Company investment decisions directly affect rates of growth of national income and also affect the characteristics of the growth of the economy. It is most important that managements have at their disposal, sound and effective decision-making criteria.

The purpose of this article will be threefold:

1. to review and comment very briefly upon the contents of the articles that appeared in the special issue;
2. to analyze problems of scope and method and
3. to suggest possible ways that it might be possible to develop meaningful decision criteria and decision procedures

I.

The articles in the issue can be classified under four general headings:

1. administrative and organizational aspects of capital budgeting;
2. specific aspects of important measurement problems;
3. critical reviews and consolidations of existing decision models and;
4. new methods.

A. In the current literature relating to capital budgeting there has been little consideration given to the discussion of administrative problems and organizational procedures.

> Horace G.Hill, Jr., using the life history of an investment proposal as an expository device, showed how the organization acted as a filter.[1] The author concerned himself with the mechanics of information flow but did not draw many inferences. It would have been useful if he had, because the organization acting as a filter and as a noise generator needs to be analyzed further.

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1. Ibid., "Capital Expenditure Management", pps. 285 to 290

> Throughout the article no clear distinction was made between the information flow required to make capital replacement decisions and capital expansion decisions. This distinction was absent in most of the articles, and yet it is a fundamental distinction that must be made if capital budgeting procedures are to be effective.

In an article that might have served better as the lead article[1] in the issue, Frank E. Norton pressed the point of caution.

> He said at the outset: "Investment decisions are inherently more complicated and less subject to rule-of-thumb treatment than are most of the decisions of a business firm relating to day-to-day operations. They relate to 'long-run' rather than 'short-run' and a mistake with respect to them is less easily rectified than in the case of more routine decisions."
>
> He goes on to state that "Business judgment of a high order is involved because they are long-run decisions which deal with an uncertain future environment about which knowledge is imperfect."

It is interesting to note that no serious attention in any of the articles was paid to the problem of forecasting the future flow of funds, forecasting obsolescence changes, forecasting future earnings rates, and so on, all of which are of unequaled importance in making current decisions about long-term capital. In all fairness it must be said that the importance of forecasting was not overlooked. But can it be said in all fairness that decision rules can be suggested to be good and effective rules when so little is known about forecasting techniques, and when so little forecasting theory has been developed?

B. When measurement problems were considered by Ezra Solomon[2] in his article and by Gordon Shillinglaw[3] in his, they did broach the problems of forecasting, but only incidentally. They seemed to be concerned mainly with the useful tasks of inquiring into certain aspects of current practice to see if capital budgeting problems were being approached correctly.

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1. Ibid., "Administrative Organization in Capital Budgeting", pps. 291 to 295.
2. Ibid., "Measuring A Company's Cost of Capital", pps. 240 to 252.
3. Ibid., "Residual Values in Investment Analysis", pps. 275 to 284.

Solomon addressed himself to a difficult question: that of determining the company's cost of capital. When should a company seek equity financing? When should it seek loan funds? Is it ever proper to work out combination financing plans? Here we see the old problem of determining how best to apply "leverage" to owner equity when faced with capital decisions. But it should be mentioned that the best financial plan need not be the best plan. The possibilities of shifting ownership control must be matched against the dilution of ownership control which might accompany financing of any type, equity or other.

Shillinglaw's major effort was devoted to a consideration of how differences in residul (or salvage) value affect investment decisions. He illustrated, with various examples, the effect that certain conditions might have upon investment decisions. The propositions that he examined in some detail were that:

1. "economic life is frequently so long and ultimate dollar realization so far away that [residual] values have very little effect on present economic decisions;"
2. "the probably residual value is so low that it can safely be ignored;"
3. "the available data do not provide an adequate basis for forecasting" and;
4. "the future is so uncertain that changing conditions may wipe out whatever values now seem probable."

He concluded that the possibility of substantial end-of-life capital value is frequently overlooked in the appraisal of the internal investment proposals.

Information about the characteristics of the "second-hand" capital goods market is lacking. In fact, it was a specific proposal of the special consultant committee reporting to The Joint Congressional Committee of the Economic Report in 1955 that more be learned about these markets. This is not an open and shut case and it may well come about that development in underdeveloped foreign markets may have very important effects upon the market for certain types of used capital goods. Given these markets, it may become very important to take residual values into account when investment decisions are made.

C. Until M. Gordon wrote his paper[1] no systematic study of the merits and deficiencies of the specific mathematical characters of the various investment decision-making models had ever been undertaken. Gordon studied three models:

1. the payout period model
2. the average investment model
3. the Terborgh model.

His findings point out very clearly the nature of the similarities and dissimilarities among the allocation methods studied. This kind of analytic effort goes a long way toward clarifying confusing aspects of investment decision making routines. After his elaborate mathematical analysis he concluded that:

1. the reciprocal of the payoff period is in fact an estimate of a proposal's rate of profit;
2. when a proposal's life is greater than its post tax payoff period, the reciprocal of the payoff period provides the best short-cut estimate of its rate of profit;
3. when a proposal's life is less than its post tax payoff period, the average investment formula provides the better short-cut estimate of its rate of profit, and;
4. the Terborgh formula provides an index of the profitability of an investment proposal that has serious limitations in the purpose for which it is intended.

It cannot be denied that these factors are important to know, if we accept the premise that some form of the discounting of future money streams is important. In the second section of this article, this basic premise will be challenged as meaningful in the case of certain potentially very important investment decision areas.

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1. Ibid., "The Payoff Period and The Rate of Profit", pps. 253 to 260.

The MAPI method, because of its professed importance as a "universal" investment decision-making device, has been under close scrutiny by many capable capital theory analysts. Joel Dean and Winfield Smith have added their thunder in an excellent article entirled "Has MAPI a Place in a Comprehensive System of Capital Controls." This is a thoroughgoing dissection and an effective one. The authors in this article are cognizant of the importance of the distinction between capital replacement problems and capital expansion problems. They seem to think that in each case the MAPI method is inadequate as a decision tool. They concluded that:

(1) it takes a virtuoso to apply the method to [expansion capital] types of investment;

(2) the two basic MAPI assumptions impose serious constraints on its flexibility for appraising the typically diverse investment proposals of a large corporation, and further that they are unduly restfictive for most non-replacement investments and even for some replacement investments, especially those with complex outlay and receipts streams;

(3) serious administrative difficulties would be encountered in a large corporation if MAPI were used as a universal index of investment worth.

Dean's and Smith's judgements have been conditions by their experiences in situations where the MAPI method was far too restrictive. Here, it seems, they raise implicitly, a far more fundamental issue than that of the propriety and utility of the MAPI method. In effect they seem to be questioning whether a single scale -- such as profitability -- can suffice as a criterion of selection among investment opportunities. Is reality so complex and are investment problems so specific that no one-dimensional scale -- or for that matter n-dimensional scale -- can serve as a rigid guide to investment making: These questions will be taken up more fully after the new method of Lorie and Savage has been mentioned.

D. James H. Lorie and Leonard J. Savage, a marketing investment specialist, and a statistician, working together on the intellectually challenging problem of capital budgeting break new ground in model building. In a tightly organized and succinctly phrased article,[1] the authors described a two-period outlay model based upon total outlay constraints. They indicated that their research was broader based than the

1. Ibid., "Three Problems in Rationing Capital," pps. 229 to 329.

article, and it will be interesting to see, in future articles, how they develop their theme further.

It is unfortunate that the authors did not include a mathematical appendix or a list of definitions. From the presentation it is difficult to understand some of their points. For example, it is difficult to see how their method differs markedly from the rate of return method used by most analysts today. If the period restraints within the "virtual" period are disregarded, and the outlays summed,and then the "present worths" are compared with the "outlays," isn't this exactly the rate of return method? The authors do not think that the rate of return method and their method are similar. They said "the rate of return criterion for judging the acceptability of investment proposals, as it has been presented in published works, is then ambiguous or anomalous [under certain conditions]." They go on to say after they describe a very specific situation involving a curious net flow of funds example that "investments of this nature are rare, but they do occur, especially in the extractive industries."

It is apparent that their method differs in detail from the usual rate of return method and that this difference is the result of their hypothesized discontinuities in required outlays. They consider the one period case somewhat trivial because in this case all that the decision-makers need do is rank the "independent" alternatives and then proceed to make investment decisions until the vailable funds for the period are exhausted, or nearly so. There is one question of perhaps a trivial nature in the case of two periods that may be very signficant in the case of an n-period model. When cash flows restraints are determined, is the flow in the n'th period a function of the aging capital investments, (resulting from depreciation allowances) made in the virtual period? If so, how is this fact accounted for in the model?

A mathematical analysis of the problem complete with fairly elaborate definitions of terms used would be very useful to the reader. It is, for example difficult to understand how the parameters in the discriminating function can be likened to Lagrange multipliers without the specifics of the derivation.

Lorie and Savage went to great lengths to establish the exact scope of their inquiry. This practice is to be highly commended, because it is undeniable that mastery is possible only within rigidly specified confines. But in their effort to be rigorous, did they in effect deal with highly unreal situations? An example might be useful to illustrated this point. In the true tradition of scholars they defined, very carefully, the characteristics of the elements of the abstract set with which they would deal. They made it quite clear that they meant to deal with the problem of selecting the optimal sub-set of independent investment proposals from the set (complete?) of independent possibilities. They defined independence in much the same way as it is defined in statistics. They said, "Investment proposals are termed 'independent' -- although not completely accurately -- when the worth of the individual investment proposal is not profoundly affected by the acceptance of others." This kind of independence would be difficult to define operationally.

Thorstein Veblen had little to say that was complimentary about the businessman, the absentee owner, and the financier and his money yardstick; but no matter how violently we may disagree with his oftentimes extreme convictions, we must marvel about the way that the man thought and the lucidity of his insights. For example in a famed book, "The Engineers and the Price System," he wrote:[1]

> "[Mechanical technology] makes up an industrial system of an unexampled character -- a mechanically balanced and interlocking system of work to be done, the prime requisite of whose working is a painstaking and intelligent coordination of the processes at work, and an equally painstaking allocation of mechanized power and materials. The foundation and driving force of it all is a massive body, by technological knowledge, of a highly impersonal and altogether unbusinesslike nature, running in close contact with the material sciences on which it draws freely at every turn -- exactly specialized, endlessly detailed, reaching out into all domains of empirical fact."

II.

Problems that develop as a result of the need to plan capital expenditures are clearly intellectually compelling. A great deal of thought has gone into the exact formulation and solution of specific problems. Science makes progress in just this way: Given objectives, we solve vast numbers of specific problems that are "pertin-

1. Lerner, Max, The Portable Veblen, The Viking Press, New York, 1950. pps. 439 - 450.

ent", and by using our general theories we integrate knowledge thus obtained with clear assurance that our intellectual endeavors will be rewarded by a clearer insight into new problem areas.

Yet the history of scientific thought is replete with examples of fruitless, unoriented research, when research is not experimental in its truest sense. Progress in developing meaningful theories of behavior is more likely to accrue if studies are empirical.

The ability of experimenters to abstract "pertinent" variables from reality oftentimes spells the difference between successful and unsuccessful research. Conceptual and mathematical formulations of problems depend upon the efficiency of specified axioms and postulates. Differences between Euclidean and non-Euclidean geometries can, of course, be traced to differences in the axiomatic formulation of the problems of geometry. The question of which model of reality is "better" is not a trivial one that can be scoffed at. Physics without non-Euclidean geometry would be very poor indeed, and so would our civilization.

Just what are we trying to do with our capital investment models? Do we really think that we can make good decisions with them? Can we justify their use? The businessman of today is looking for good decision-making tools; does he use the ones that are available to him? Surely we must blush, because we do not know whether he uses them. But most of us suspect that he does not. Why? Is he unreasonable or are the models inadequate? If he does use them, in what situations are they used most effectively? If he does not use them, why doesn't he?

Before proceeding to specific recommendations let us consider some questions that were raised in the first section of this article.

First, did the authors of the various articles distinguish clearly between two cearly different kinds of investment decisions, namely

(a) replacement decisions and
(b) new investment decisions?

Secondly, are there any serious technical difficulties with the models?

Finally, is it reasonable to assume that a generalized decision-making model can be constructed, with assumptions that are reasonable?

A. Dean and Smith were the only authors that made explicit mention of the importance of the distinction between replacement capital problems and new investment problems. Is the distinction important? Consider them in order:

> Consider a firm or a plant as an organism that has discrete parts that wear out over time either as a result of normal depreciation or obsolescence. Productive equipment has to be replaced as it wears out if it is the policy of the company to maintain its output position. If a constant price level is assumed, it is not unreasonable to assume that worn-out equipment can be replaced out of funds that accrue internally as a result of full-cost pricing of completed and sold production. Theoretically it might be assumed that the freed funds and the need to replace worn-out equipment become exact offsets and hence contribute nothing to a fund for the expansion of capital. In the practical case, of course, there is enough flexibility in providing for replacement, so that in the short-run, funds can be allocated to capital expansion projects. But this question arises: If, in fact, replacements are technologically determined, then is it not true that the utility of the discounted income stream may be reduced to a minimum discounted cost (including depreciation allowances) problem among similar kinds of alternatives that are mutually exclusive? If the minimum cost approach is proper here, the problem of choosing an alternative is almost trivial. Restraints cannot operate in the system because the capacity must be replaced. Is the replacement problem trivial? Does the Lorie-Savage model claim to consider the question of investment selection in this kind of circumstance? Without definitions, the mathematics, and an indication of the problem area with which they are dealing, we do not know.
>
> Now consider the case of capital expenditures for expansion. What group of "independent" alternatives could Lorie and Savage be referring to? Perhaps a complete steel producing plant or a complete fabrication plant? Or probably a plant for new product A versus a plant for new product B? There is no intention here to demean the importance of their contribution, but under what reasonable circumstances does their model apply, if their model deals with the problem of allocating funds for expansion projects. And we must remember that they argue that their method does give a useable decision procedure, so that at that point they are beyond the realm of scholarship and must divest themselves of the armor of their mathematical rigour. The criterion here is: Is it a good, practical model?

B. If it can be argued that research activity and new product development are of singular importance to an expanding economy, then one can argue that there is the possibility of a bias against such prospective projects when utilizing any of the decision-making methods that utilize as their basis the discounting of future income streams (even though adjustments are made for differences in time horizons among alternatives). In all formulations of the streams, we are dealing with money flows, and are not in any way weighting our decisions with measurements of the costs of opportunities foregone.

If for example there were outlay restraints given and a new product development with great long-run potential was competing with projects that had a near term advantage, at a twenty percent interest rate, future net earnings of great magnitude discounted over ten or more years would not be very large. If we note that most new product developments are costly and time-consuming,(with a need for farsighted managers to finance a new product through a period of basic research, pilot plant operations, building of production and management staffs, constructing production facilities and developing effective channels of distribution sequentially) then it follows that such projects are at an "unfair advantage" when competing with quick, above average, yield possibilities. Such developments are characteristic of capital expansion projects. Are the discounted future income stream models inadquate in these situations? If so, how can managers be expected to use them? What methods are consistent with long-run survival?

C. In previous discussions we have seen that capital budgeting for replacement may be a trivial problem area and that capital budgeting for expansion may carry us well beyond the confines of a single-scale model; namely, profitability. What then are the areas of possible use of the techniques? Are there any?

Given the present state of the arts and the information that we have about actual techniques used by decision-makers, there are no answers to these questions. We just don't know! But one fact seems to stand out in the discussion: We have not demonstrated that these techniques have any more utility than do the age-old procecures of letting experienced businessmen use their combined "judgments" with some reasonable empirical guides. If no meaningful model for this judgment can be found and if it cannot be demonstrated with reasonable assumptions, that the business decisions being made are logically inconsistent, then existing models are inadequate. This appears to be the case even though no mention has been made of inadequate theory and technique in forecasting. The implications are clear; we must learn something about methods that are used. We must develop an experimental science of investment decision making.

III

In previous sections, problems of scope and method have been touched upon. It has been suggested that current decision-making problems in the area of replacement are relatively unimportant and that decision-making problems in some important kinds of capital expansion situations could not be treated adequately without present tools. There is much need for an adequate theory of forecasting and for more knowledge about the nature of the investment decision problem and about current practices. The specific economics of the various industries and product lines will play an important role in the formulation of decision-making models. There is every reason to believe that more widely applicable decision rules can be developed, but until then we are in no position to place too much faith in our methods. Are we fortunate that businessmen do not put complete faith in mechanical decision procedures? Perhaps so!

THE PAYOFF PERIOD AND THE RATE OF PROFIT[1]

Reviewed by:

Adam Abruzzi
Stevens Institute of Technology

This paper looks into the comparative merits of certain common formulas for evaluating the profitability of an investment proposal. The "true" rate of profit, which is used as a basis of comparison, is assumed to be obtainable from "the well-known formula for the present value of an annuity."

The author points out that solving for the "true" rate of profit would generally be tedious and, also, that there is a considerable range of error in estimating future receipts. This is why he compares estimates of the rate of profit based:

(1) on the payoff reciprocal estimate; and

(2) on the average investment formula.

It is worth noting, however, that the latter two formulas also required an estimate of future receipts and, hence, are subject to the same error complained of in using the "true" formula.

Indeed, it is difficult to see why one would use the payoff reciprocal formula at all since it makes the assumption that the equipment will earn the same amount forever, i.e. , n is infinite. Thus this formula can be obtained directly from the "true" formula by putting n equal to infinity.

A study of the average investment formula, which incidentally involves an added assumption about depreciation, shows that the rate of profit is multiplied essentially by the averaging factor of 1/2. It is not surprising that an average concept of this kind should yield an average result in the long run (i.e., with n infinite), whihc is twice as large as the results obtained from the non-average concepts in the first two formulas.

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1. The Journal of Business. The School of Business of the University of Chicago, University of Chicago Press, Chicago, Illinois, Volume XXVIII, October 1955. "The Payoff Period and the Rate of Profit," Myron J. Gordon.

In the reviewer's mind it is of value to show how certain fairly standard formulas compare under different conditions, and it is also of value to indicate the magnitude of the errors made by the second two "short-cut" formulas. However, the "short-cut" formulas, it should be remembered, involve added and sometimes hidden assumptions which means that they are really estimating something different from the rate of profit as determined from the "true" formula. It would seem wiser to look for direct (perhaps mathematical) approximations to the "true" formula, if this is really the appropriate one, than to try to approximate that formula by formulas based on different assumptions.

These comments, of course,are actually a criticism of common practices rather than the author, who does a solid, workmanlike job of showing how the formulas do compare. The author also looks into certain related questions, such as the tax problem, and he makes some useful comments on the Terborgh formula. The reviewer's overall impression is that the paper should be read by all students of this highly important but perplexing subject.

Three Bibliographies

By James B. Weaver
Atlas Powder Co., Wilmington, Del.

Need Help in Finding Cost Data?
SUBJECT INDEX lists 402 individual items involved in chemical engineering economics. Key numbers there refer to the...
BIBLIOGRAPHY, listing 351 articles dealing with equipment costs, operating costs, estimating methods and project analysis.
Chemical Engineering, October 1954

More Help in Finding Cost Data
SUBJECT INDEX helps locate the references dealing with the specific problem or estimate.
BIBLIOGRAPHY, listing 186 recent references, is annoted to indicate contents of articles.
Chemical Engineering, June 1955

Chemical Cost and Profitability Estimation -- 1955
SUBJECT INDEX lists 460 individual items on chemical cost estimation
BIBLIOGRAPHY, listing 268 articles dealing with Unit Operations-Investment and Operating Cost Data, Auxiliary Equipment-Investment and Operating Cost Data,Techniques for Expressing Profitability,Improving Product Cost and Investment Estimates, and others.
Industrial and Engineering Chemistry, May 1956

Review of:

"Applying Engineering Economics to Materials Handling"
October and November issues of Modern Materials Handling

by

Ralph O. Swalm
Syracuse University

It is a difficult task to review Colonel Day's series of two articles for this publication because, although the articles offer an excellent guide to effective use of materials handling equipment, about their only relation to engineering economy is that the application of the principles they offer would lead to operating economies.

In a brief description of these articles, the publisher states "Here is .... a series of articles that take fundamental economic principles and apply them to the practical problem of materials handling." The principles that are so described are:

1. Use mechanical equipment that best serves the purpose, and improve its operation with accessories and attachments.
2. Schedule maintenance and plan future repairs.
3. Keep plant and equipment operating at capacity.
4. Use the largest handling unit practicable.
5. Move in the straightest line practicable using gravity if possible.
6. Apply work simplification techniques.
7. Operate at the fastest economical speed.
8. Measure efficiency in dollars per unit of material handling.
9. Reduce fatigue.
10. Replace old equipment with new whenever necessary.
11. Keep safe-- it is faster and cheaper.

The articles consist of the statement of these principles, an elaboration on each, and a series of check-lists to aid in the effective us of each principle.

Your reviewer submits that those of the principles that might be classed as economic principles are poorly stated. For example, #8 states, "Measure efficiency in dollars per unit of material handling." But is not efficiency the ratio of output to input? Effectiveness may be measured in dollars, but not efficiency. (Parenthetically, shouldn't the final word be handled rather than handling?)

Again, principle # 9 states "Replace old equipment with new whenever necessary." Should it not be replaced when economically sound rather than waiting until it becomes necessary? And the engineering economist would also question such check list items under this principle as:

> "2. Would the new equipment pay for itself in a reasonable time -- two to five years for standard" (equipment)
>
> "3. Is all equipment amortized according to pamphlet "F", Internal Revenue Department."

In summary, while these articles offer the operating man a useful guide to reduced materials handling cost, they are of little interest, despite their title, to an engineering economist.

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Recently Published:

Determinants of Capital Expenditures

By Robert Eisner

This is the second in a series of monographs on business expectations financed by the Merrill Foundation. It is obtainable from the Bureau of Economic and Business Research, University of Illinois, Urbana, Ill. Based on detailed interviews with executives of large manufacturing corporations, this pioneering study attempts to synthesize interview data and economic theory in an analysis of the factors influencing capital expenditures. 106 pp $1.50.

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Report on 1955

MAPI SUMMER SEMINAR ON DYNAMIC EQUIPMENT POLICY

The first of a series of summer seminars on equipment acquisition and replacement analysis was held by the Machinery and Allied Products Institute during the week of July 11, 1955, at Beloit College, Beloit, Wisconsin. Conducted in conjunction with the National Center of Education and Research in Dynamic Equipment Policy at Illinois Institute of Technology, the Seminar was open to participation on the part of management consultants, plant and industrial engineering, methods, planning and capital budgeting representatives of capital goods producers.

This initial and exploratory workshop on the theory of dynamic equipment policy, and its application in economic comparisons determining the proper timing of equipment acquisition and replacement, is one more channel for the improvement of industrial practice. Based on the experience gained in this seminar, further conferences are being planned for wider participation in industry. The importance of sound standards of equipment practice, obviously of benefit to capital goods producers through the most rapid turnover of capital facilities economically justified, is even greater for the economy as a whole.

Opening the Conference, Mr. George Terborgh, Research Director, Machinery and Allied Products Institute, and Seminar Chairman, discussed the background of MAPI study in dynamic equipment policy and the basic problems and analytical techniques in equipment analysis work. He also presented MAPI's current research program of analysis and restudy of equipment theory, policy and practice which includes:

(a) clarification of the terminology used in the MAPI method of equipment analysis;

(b) expansion of the MAPI formula to present to the analyst a range of choice or options appropriate to varying conditions;

(c) expansion of the treatment of tax effects of depreciation and development of modifications of the formula to permit ready adaption to differing tax situations, and a number of other developments of the subject.

Collaborating with Mr. Terborgh in the presentation of the MAPI method were Mr. Gerald J. Matchett, Director, National Center of Research and Education in Dynamic Equipment Policy at Illinois Institute of Technology; and Mr.Alexander Konkle, Vice President, Machinery and Allied Products Institute.

Insights into the application of equipment analysis work in their respective companies were provided by Mr. J.A. Beebe, Cincinnati Milling and Grinding Machines, Inc.; Mr. James E. Brown, Treasurer, The Cooper-Bessemer Corporation; Mr. Edson Gaylord, Assistant to the Vice President, The Ingersoll Milling Machine Company; and Mr. Duncan J. Stewart, President, Barber Colman Company.

Mr. Robert Oppenlander, Senior Associate, Cresap, McCormick and Paget, discussed the organizational requirements within a firm essential to carrying out an objective and systematic approach for analyzing acquisitions. The purpose and place of the lease as an alternative means of acquiring industrial equipment was presented by Mr.Richard R. MacNabb, Research Economist, Council for Technological Advancement.

Essential steps toward a more scientific equipment policy include familiarity with problems related to equipment analysis, special training in the procedures available and the study of case materials based on company experience in equipment analysis work. The MAPI Summer Seminar is designed to help meet these needs.

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Coming Next Month:

"Use of a Mathematical Model to Determine the Effects of the Business Cycle upon Engineering Economy Decisions." Based upon a dissertation prepared by Robert M. Eastman, University of Missouri, under the advisorship of Professor C.A.Anderson, for the Ph.D. degree granted January 1955.

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